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Mineral loss on adjacent enamel glass ionomer cements restorations after cariogenic and erosive challenges

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ABSTRACT

Objectives: the purpose of this study was to determine the mineral loss on surrounding enamel restored with glass ionomer cements (GIC) after erosive and cariogenic challenges.
Methods: Bovine enamel specimens were randomly assigned into six groups according to the restorative material: G1 – composite resin; G2 – high viscous GIC; G3 – resin-modified glass ionomer with nanoparticles; G4 – encapsulated resin-modified GIC; G5 – encapsulated high viscous GIC; G6 – resin-modified GIC. After restorative procedures, half of specimens in each group were submitted to caries challenge using a pH cycling model for 5 days, and the other half were submitted to erosive challenge in citric acid for 10 min. Before and after the challenges, surface Knoop microhardness assessments were performed and mineral changes were calculated for adjacent enamel at different distances from restorative margin.
Results: Data were compared for significant differences using two-way ANOVA and Student–Newman–Keuls tests ($p < 0.05$). Erosive challenge significantly reduced enamel surface hardness, but no significant difference was observed irrespectively restorative materials ($p > 0.05$). The cariogenic challenge promoted a higher surface hardness loss for the resin-modified GIC (G4) and only for the High viscous GIC (G2) an increase in surface hardness was observed. For enamel analyses, significant differences were observed with respect to the different materials ($p < 0.001$) and distances ($p = 0.023$). Specimens restored with the composite resin presented higher mineral loss and specimens restored with the conventional high viscous GIC and the encapsulated resin-modified GIC presented the lowest values for mineral loss.
Conclusion: The GICs exerts protective effect only for cariogenic challenge.

1. Introduction

Glass ionomer cements (GIC) were introduced to clinical practice almost 40 years ago and thereafter the considerable advantages of their use have transformed this material into a very useful adjunct to restorative dentistry. Their major properties include ion exchange adhesion to both dentine and enamel, biocompatibility and the continuing fluoride release during the existence of the restoration. Several studies have confirmed that glass ionomer cement is capable of retaining fluoride delivered by dentifrices or topical fluoride application at the material surface, which can be then released slowly and taken up by the adjacent sound enamel as well as the demineralized dentine.[1,2] Thus, the ability of glass ionomer cements to promote a cariostatic effect makes these materials suitable for the inhibition of secondary lesions development in adjacent dental hard tissue, which has been considered to be the main reason for the replacement of restorations.[3,4]

Resin-modified GICs as well as high viscous GICs were developed in an attempt to improve its physical properties and

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to accelerate the long setting reaction, which can compromise their early strength and initial wear.[5] The hybrid cement contains in addition to the glass-ionomer cement, organic monomers, in general HEMA (2-hydroxyethyl methacrylate), and an associated photo-sensitive initiator system, allowing the cement to be cured also by exposure to blue light. Recently, a new generation of resin modified GIC was launched in attempt improving mechanical and aesthetics properties. This new type of material presents nanoparticles in its composition, which is supposed to allow lower surface wear and staining. However, there is a lack of studies concerning the anti-cariogenic effects of this material.

Considering high viscous GIC, superior mechanical properties and fast setting reaction can be achieved by increasing the powder/liquid ratio. These cements are indicated specially for performing Atraumatic Restorative Treatment (ART) and favourable results with respect to their physical properties have been documented.[6] Nevertheless, reports have suggested that the newer more-viscous GICs and resin-modified GICs release considerably less cumulative fluoride ions than less-viscous aesthetic restorative.[7] Although remineralization ability to surrounding enamel has been confirmed by GIC under an acidic attack after cariogenic challenge,[8] there is little evidence about the influence of their properties with respect to an erosive challenge.[9,10]

Furthermore, there are few studies about the novel types of glass ionomer cements, considering both the cariogenic and the erosive challenge. It is possible that these materials present lower rates of fluoride release, and this fact might hind its protective effect against demineralization.

Dental erosion is a result of mineral loss from the tooth surface due to a chemical process of dissolution not involving acids of bacterial plaque origin. Sources of acids can be extrinsic and intrinsic, and erosive intensity is modified by quality and quantity of saliva.[11] Extrinsic factors mostly comprise the consumption of acidic foods and beverages, such as soft drinks and fruit juices whilst eating disorders and gastric reflux are the major constituents of the intrinsic factors.[12]

When substance loss of tooth structure reaches a certain degree, oral rehabilitation becomes necessary and restorative materials generally used in clinical practice can be placed to reestablish tooth function and aesthetics, to prevent further progression or to control hypersensitivity caused by dentine exposure. Considering that the knowledge about the characteristics of a restorative material is an important aspect for its indication in daily clinic, the aim of this study was to assess the effect of erosive and cariogenic challenges on mineral loss on enamel surrounding restorations with GICs.

2. Materials and methods

2.1. *Specimens preparation*

One hundred and thirty one enamel blocks (4 mm × 4 mm × 3 mm) were obtained from bovine incisor teeth, which had previously been stored in tap water at room temperature for 30 days. The enamel surfaces were examined at 2× magnification with a stereoscopic microscope (Nikon, Tokyo, Japan) to choose sites without caries, cracks or intrinsic staining and then the teeth were cut using low speed saw (Labcut 1010, Extec Corp., London, England) and the enamel surface of the blocks was then ground flat with water-cooled on a rotating polishing machine. After that, samples were maintained in 100% humidity environment.

Standard cavities, 1-mm diameter for 1.8 mm deep, were prepared in the centre of the blocks surfaces of each tooth, with a cylindrical plain cut diamond bur (n. 1090, KG Sorensen, Barueri, SP, Brazil) at high speed under water cooling. Following the preparation of the cavities and before the restorative procedures, teeth were kept in a relative humidity environment. Specimens were then randomly distributed into six groups, according to the restorative materials used:

Group 1 ($n = 20$): Universal composite resin (Filtek Z350, 3M ESPE, USA).
Group 2 ($n = 23$): High viscous GIC (Fuji IX, GC America, USA).
Group 3 ($n = 22$): Resin-modified GIC with nanoparticles (Ketac Nano^{TM}, 3M ESPE, USA).
Group 4 ($n = 22$): Encapsulated resin-modified GIC (Riva light cure^{TM}, Southern Dental Industries-SDI, Australia).
Group 5 ($n = 22$): Encapsulated high viscous GIC (Riva Self Cure^{TM}, Southern Dental Industries-SDI, Australia).
Group 6 ($n = 22$): Resin-modified GIC (Vitremer, 3M ESPE, USA).

Universal composite resin was light cured for 40 s, the resin-modified GIC specimens were light cured for 20 s (Riva light Cure) or for 40 s (Vitremer) with a dental curing unit (Ultralux, Dabi Atlante, Ribeirão Preto, Brazil), according to manufacturer's instructions. Glass ionomers were mixed following manufacturers' instructions. When necessary, the surface protection was also conducted accord to the recommendations of each manufacturer. One of the researchers performed all clinical procedures to help the standardization. After the restorative procedures, specimens were placed in a container with a remineralizing solution (1.5 mM/L $CaCl_2$, 0.9 mM/L NaH_2PO_4, 150 mM/L KCl, adjusted to a pH of 7.0), where they were left for 24 h.

To the end of this period, the sample surfaces were planed out with an automatic grinding/polishing machine (Ecomet 3, Bueller, IL, USA), with a sandpaper disc of 600, 1200 and 1400 grit, under running water, for a period of 60 s and polished with felt paper wet by diamond paste (1 and 0.25 μm). Baseline surface microhardness (SMHb) measurements of the adjacent enamel were performed using a Knoop indentor attached to a microhardness tester (Shimadzu Micro Hardness Tester HMV-2, Shimadzu Corporation, Kyoto, Japan). Only enamel specimens with microhardness values ranging from 300 to 370 KHN were considered for the study. Therefore, some of them were discarded after the measurements.

Three lines of indentations were performed on the enamel surface at distances of 100, 200, 300, 400 and 500 μm from the external margin of the restoration. The indentation load was 25 g with 15 s dwell time. After the microhardness measurements, the samples in each group were randomly splitted into two subgroups, according to the type of challenge.